University of Alberta

# The Frequency of and Reasons for Hospital Readmission post Percutaneous Coronary Intervention

By

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**Abstract**

*Background:*

Percutaneous Coronary Intervention (PCI) has become an important and effective way of treating heart disease; however the occurrence of hospital readmission post PCI is not well documented.

*Objective:*

To determine the frequency of and reasons for readmission to hospital post PCI.

*Design & Methods:*

The frequency of hospital readmissions were tracked for six months following PCI using the APPROACH registry database. The incidence of and reasons for hospital readmission were determined using the Capital Health Region Administrative Database and the ICD-10 coding for hospital readmission.

*Results:*

It was observed that 8% of patients were readmitted to hospital within six months of PCI and 32% of patients visited the Emergency Room. The top reasons for readmission were chest pain, atherosclerotic heart disease, myocardial infarction, bleeding/complications with anticoagulation and procedural complications. Factors shown to be predictive of readmission to hospital were congestive heart failure, pulmonary disease, malignancy, liver disease and female gender.

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## Dedication

I would like to dedicate this work to my husband, Les, who supported me throughout this entire journey. Thank you for always encouraging me to be true to myself and to pursue my goals and dreams. And to my parents, Bryan and Judy Magyar, who instilled in me the love of learning and the fortitude to achieve my goals.

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# Chapter One

## Introduction

It has been estimated that 1 in 4 Canadians have Coronary Artery Disease (CAD) [1]. In 2005, Statistics Canada reported diseases of the heart as the second leading cause of death among Canadian men and women, second only to cancer [2]. CAD has a profound impact on our society and cardiology researchers are working hard to develop new and innovative ways to treat this disease. Percutaneous Coronary Intervention (PCI) as a means of treating CAD was first introduced and performed by Andreas Gruentzig in 1977[3]. Since its introduction, PCI use has become increasingly common [4] with 2585 PCIs being performed in 2004 within the Capital Health Region in Edmonton, AB Canada[5]. Although proven to be a safe and effective treatment modality for CAD, [4] complications following PCI may arise. While questions of morbidity and mortality post PCI have been extensively researched, the frequency of readmission post PCI has not been well documented, nor have the reasons for these readmissions.

## Purpose of the Study

The purpose of this research study was to explore and describe the frequency of and reasons for hospital readmission post PCI.

## Significance of Study

Determining the frequency of and reasons for hospital readmission post PCI will assist health care professionals to ascertain whether there is a high prevalence of patients experiencing complications post PCI that require readmission to hospital. Current health care practices attempt to give all patients the support and education they need to prevent ensuing complications. However, with increasingly shorter hospital stays, health care providers are less able to provide these measures. A better understanding of the concerns and complications post PCI will assist clinicians

with tailoring the teaching and support provided to patients in an attempt to avoid costly and unnecessary hospital readmissions. Further data on hospital readmission may also provide clues to the effectiveness of current discharge planning programs as well as the continuing care needs of patients[6]. Additionally, knowledge of the trends of hospital readmission may result in the development of solutions to the underlying issues [7].

Research indicates that an increase in teaching and support post PCI leads to a decrease in complications and an increase in patient satisfaction and quality of life[8, 9]. Lindsay et al. (2000) observed that nurse managed clinics are a successful way of addressing patient's needs and concerns post PCI [8]. Although their study did not examine hospital readmission rates, patients were noted to engage in more lifestyle changes and risk factor modifications and reported a higher overall quality of life at six weeks and six months post PCI ($p \leq 0.05$) when attending a nurse managed clinic as compared to the "usual" follow-up care [8]. Dendal et al. (2005) demonstrated that the incidence of adverse events post PCI (restenosis, angina pectoris, need for revascularization and death) were all significantly reduced ($p<0.005$) when patients participated in a 3 month multi-disciplinary cardiac rehabilitation program [10]. Although rehospitalization was not specifically assessed, it was inferred that an overall decrease in post PCI complications would result in a decrease in re-hospitalization as well as a decrease in overall health costs.

In-hospital outcomes post PCI are continuing to improve,[11, 12] as hospital length of stay decreases[13]. Laskey et al. (2005)[13] noted that mean length of hospital stay has decreased significantly from 2.65 days in 1997 to 2.21 days in 2002 ($p \leq 0.001$), while the occurrence of clinically significant complications occurring after hospital discharge have stayed the same and often are not recorded [13]. This may

result in an inaccurate assessment of procedural safety and outcomes as procedural complications may be considerably underestimated.

Unplanned hospital readmissions are often viewed as a costly and preventable occurrence and have been associated with a lower quality of in-hospital patient care [14, 15]. Weinberger et al. (1996) reported that hospital readmissions account for up to half of all hospital admissions and are responsible for 60% of total hospital costs. Aside from the financial implications, hospital readmissions have a detrimental effect on individual patients' lives such as time lost from work, family and other life commitments [7]. It is therefore imperative to determine the frequency of post discharge complications requiring rehospitalization in order to ensure patient safety and positive outcomes.

## Chapter Two

### Literature Review

A literature review was conducted to locate published studies describing hospital readmission post PCI, occurrence of hospital readmission and occurrence of complications post PCI by searching MEDLINE & CINAHL databases from 1966 to present.

*Percutaneous Coronary Intervention*

PCI is an umbrella term applied to all techniques used to relieve coronary artery obstruction [4]. It is a common modality offered to patients with CAD and is an alternative to coronary artery bypass surgery. As CAD progresses, atherosclerotic plaques build up in the lining of the coronary arteries. These plaques may eventually lead to an obstruction of the arteries, creating a restriction of blood flow. The narrowed coronary arteries limit the supply of blood to the myocardium, which may result in ischemia leading to angina pectoris or acute myocardial infarction. PCI is a technique used to widen or open these narrowed arteries. A balloon is inserted into the coronary artery and inflated at the narrowing, thus remodeling the plaque into the wall of the artery. Often, a coronary stent, which is a wire scaffolding device, is permanently placed into the artery wall to provide support and help keep the artery open [1, 16].

*Complications post PCI*

The American College of Cardiology and the American Heart Association (ACC/AHA) have published a set of guidelines and recommendations describing the indications and contraindications of PCI in the clinical setting [4]. A successful PCI procedure is described as producing a substantial enlargement of the coronary artery at the targeted narrowing and is without any in-hospital complications. However, as

with all procedures, PCI may have complications. Some of these include: myocardial infarction (MI), coronary artery bypass grafting (CABG), stroke, vascular complications including bleeding, occlusion, dissection, pseudoaneurysm or arteriovenous (AV) fistula at the arterial access site and contrast agent induced renal failure [4].

The incidence of revascularization post PCI occurring anytime from 30 days to one year post PCI has been reported as 1.6%-6.7% for CABG [11, 12, 17] and 16.3%-17% for repeat PCI [10, 17-19]. The incidence of post PCI MI has been reported as 2.1%-4.3% up to one year post PCI [10, 18, 20].

*Vascular Complications post PCI*

In a retrospective review of 7690 catheterizations performed in Vermont over a 40-month period from January 1987 to April 1990, Ricci et al. (1994) documented a vascular complication rate of 3% (n=1207) [21]. These consisted of hematoma (0.9%), pseudoaneurysm (0.1%), thromboembolism (0.1%), hemorrhage (0.8%), AV fistula (0.05%), and infection (0.05%). The more severe vascular complications that were noted required surgical intervention and were found to be related to the arterial access site [21]. Swedish investigators reviewed all patients who had undergone PCI or coronary angiogram between 1987-1991 and noted a 0.77% vascular complication rate (n=392) [22]. Complications included pseudoaneurysm, thromboembolic episode and excessive bleeding. Interestingly, some of the complications were detected by questionnaire, indicating the complication occurred after discharge. Of note, this is the only study found which identified vascular complications occurring post discharge [22].

While these studies suggest that vascular complications post PCI occur infrequently, others have suspected that these complications may be under-reported[23]. A prospective study following PCI patients for eight weeks post procedure

revealed that 41% of patients developed a hematoma of any size, 11% developed a hematoma >5cm and 4% of patients developed a hematoma significant enough to require prolonged admission to hospital (n=304). Only 1% of patients developed a pseudoaneurysm; however 82% of patients reported groin pain [23]. Likewise, a four month retrospective chart audit done in 1984 in Denmark found that 12.1% of PCI patients experienced hematomas >5cm (n=141) [24].

A significantly larger retrospective analysis of medical records from 10, 669 consecutive PCI patients observed a similar complication rate, with 10.27% of patients having peripheral vascular complications including hematoma >4cm (70.3%), groin bleeding associated with >15 point hematocrit drop (21.9%), pseudoaneurysm (14.4%), AV fistula (10.2%), retroperitoneal hematoma (4.68%), limb ischemia (1.7%) or the need for surgical repair (15.4%) [25]. It was also noted that patients who experienced peripheral vascular complications were more likely to experience other complications such as cerebrovascular accidents (CVAs), acute renal failure, requirement of blood transfusion and need for emergency CABG [25].

Furthermore, a recent prospective study of 1570 patients undergoing PCI between October 2002 and September 2003 found that 2% of patients experienced vascular complications with 1.3% of patients experiencing major groin hematomas, 0.4% developing retroperitoneal hemorrhage, 0.1% developing pseudoaneurysms and 0.3% having common femoral or external iliac artery dissection [26].

Vascular complications, while seemingly less severe than other complications, can create a significant burden for the health care system as well as for patients. Patients who develop groin hematomas after PCI are thought to have a decreased quality of life for 1-2 months following the procedure secondary to an inability to walk normally and an unpleasant tingling sensation in the leg [24].

*Chest Pain post PCI*

With the primary reason for performing PCI in a non-emergent setting being angina pectoris, it is unfortunate that many patients are left with chest pain following a seemingly successful PCI. This phenomenon has been reported by numerous investigators. Studies have revealed that chest pain frequency is 23-25% [27, 28] without stent insertion and 30% [29] with stent insertion in spite of no rise in creatine kinase-MB isoenzyme or troponin I levels [29] and only 12% of patients having significant ST changes on ECG [27]. Recurrence of coronary artery stenosis has been variably reported to be the cause of post PCI pain in as few as 35% of patients[27], and in as high as 62% of patients [28, 29], however 27% of patients that did not experience any post procedure chest pain are still noted to have restenosis at follow up angiograms [27]. Other reasons noted for post PCI chest pain are new, significant coronary narrowings (15-20%) and incomplete revascularization (9-13%) [28, 30].

The time from PCI to recurrent angina ranges from a median of 4 months [28] to a mean of 5.3 months [30]. Patients reporting angina between 1-6 months post PCI had a high likelihood of restenosis [28, 30] while patients reporting angina within one month of the procedure are less likely to experience restenosis [30]. Recurrence of chest pain 6 months or more after PCI is most frequently attributed to the development of new coronary artery stenosis [28].

Of those patients having no significant coronary artery narrowing, 64% describe symptoms typical of angina pectoris [28], however one group of investigators noted that most patients report the characteristics and intensity of the chest pain to be different from that experienced prior to PCI, suggesting the pain does not have an ischemic cause [29].

While chest pain post PCI is common, it is important to remember that the preceding studies report restenosis as being the primary cause of chest pain 35-62%

of the time [27, 28, 30]. Therefore, not only it is important to thoroughly assess patients complaining of chest pain post PCI, it is important to educate patients on the actions that should be taken. A study assessing patient responses to recurrent chest pain post PCI found only 14% responded to the chest pain by taking nitroglycerin and either notifying their physician or going to an emergency department; 22% of patients did not take nitroglycerin but either saw their physician or went to an emergency department within 24 hours of the onset of chest pain [31]. Finally, 64% of patients either ignored the chest pain or took nitroglycerin, but waited weeks to months to notify their physicians. Reasons given for the inappropriate response to chest pain post PCI were denial that the pain may be cardiac-related, lack of understanding of the disease process, lack of understanding of the uses of nitroglycerin and a lack of understanding that restenosis could occur. The majority of patients who participated in this study had longer hospital stays where more time was available for teaching, suggestive that an even higher proportion of post PCI patients with shorter hospital stays may respond inappropriately to chest pain. There is therefore a need for comprehensive teaching and follow-up post PCI [31].

*Hospital Readmission*

Research indicates that 5%-29% of patients are readmitted to hospital within thirty days of any hospital stay [14, 32-36]. Relapse or complications related to the original illness have been reported to be the most apparent causes of hospital readmission [37]. Moreover, healthcare practitioners caring for these patients felt most unplanned readmissions were related to avoidable communication breakdowns and inadequate discharge planning [37].

Other possible causes of hospital readmission relate to the patient's age [7, 32], diagnosis [7, 32, 36], history of chronic illness [7], lack of discharge teaching [7], lack of follow up appointments [7, 34], patient non-compliance [7], length of hospital stay [33, 34, 36],

financial status [32, 34], severity of illness [32, 33], degree of available support [33, 34] and discharge on Fridays [38]. The top five diagnoses resulting in hospital readmission are (1) heart failure and shock, (2) angina pectoris, (3) stroke, (4) pneumonia and (5) cancer [7]. These diagnoses account for 65% of all hospital readmissions, with diseases of the cardiovascular system being the most mentioned diagnosis related to hospital readmission [7].

To determine the incidence of adverse events among patients discharged from hospital, a prospective study was conducted in Ottawa in 2002. Of the 328 patients included in the study, 23% experienced an adverse event after discharge from hospital. Of these, 66% of the adverse events caused only symptoms; however 12% led to an emergency department visit and of these, 17% were readmitted to hospital. The study suggested that close follow up after hospital discharge is not only important, but vital in order to improve patient safety and outcomes after hospitalization [39].

It has been observed that communication between hospital and community care givers is often poor. Thus, the question was raised whether post discharge outcomes would improve if patients were followed up by the hospital caregiver [40]. This was explored in a large cohort study of 938,833 patients in Ontario. Overall, 7.7% of patients either died or were readmitted to hospital after discharge. Interestingly, patients who were followed up by their hospital caregiver were less likely to die or be readmitted to hospital in the first 30 days following discharge. The differences in outcomes may be explained firstly by an inadequate amount of information being transferred to community physicians. As well, the discharging caregiver is more familiar with the hospital course and potential complications, therefore potential problems or concerns may be detected sooner and resolved earlier[40]. While the type of patient follow-up may be an important factor in reducing

patient hospital readmission, other factors may be involved. It was also found that patients discharged on Fridays are more likely to either die or be readmitted to hospital than those patients discharged on other days[38].

*Hospital Readmission and PCI*

Few published studies could be found that specifically examined hospital readmission of patients who underwent PCI [13, 41, 42].

Lubitz et al. (1993) assessed patients aged >65 years undergoing PCI and found that 34.6% of patients were rehospitalized for an event related to PCI within one year of the procedure [42]. The rate of repeat PCI within one year was 14 per 1000 discharges and the rate of CABG within one year of the original PCI was 61 per 1000 discharges [42]. Halon et al. (2002) followed 179 post PCI patients for a median period of thirteen years and observed a readmission rate of 48% at one year and a decrease to 15%-26% annually for the subsequent 11 years [41]. Unfortunately, planned readmissions were included in both of the studies' rehospitalization numbers, so it is not clear how many patients were actually readmitted to hospital for PCI related complications. It is also debatable whether the Halon et al. readmissions were a direct cause of the PCI or merely a progression of CAD over the extensive period of time the patients were followed.

In another large study, rates of in-hospital adverse events post PCI (death, MI and repeat PCI or CABG) were examined, along with rates of post hospital discharge adverse events (death, MI, nonscheduled rehospitalization and repeat PCI or CABG) (n=6676)[13]. In total, 18.6% of patients experienced death or MI, 50% of patients underwent repeat hospitalization and 32% required repeat PCI or CABG. The in-hospital adverse event rate was noted to decrease significantly ($p<0.001$) from 5.4% in 1997/1998 to 3.1% in 2001/2002, however, the 30 day post discharge adverse event rate went unchanged ($p=0.009$) from 5.1% in 1997/1998 to 4.9% in 2001/2002.

It was suggested that when only in-hospital adverse events are reported, an underestimation of the "actual" number of procedurally related events ensues. Additionally, although in-hospital adverse event rates have decreased, post discharge adverse events have stayed the same, indicating that more effort needs to be spent on supporting patients following discharge in order to decrease the number of complications experienced within the first 30 days [13].

*Conclusion*

Few studies have investigated the incidence of hospital readmission post PCI. The ACC/AHA guidelines specify that potential complications for PCI include MI, CABG and stroke as well as vascular complications and contrast agent induced renal failure [4]. Despite the opinion that vascular complications are only a "nuisance" complication [50], these complications along with other minor complications may be significant enough to require readmission to hospital impacting not only the hospital, but the patient's life as well. Knowledge about the frequency of and reasons for hospital readmission post PCI can assist health care professionals to identify potential areas where patient teaching and support should be improved or enhanced; thus improving not only the quality of care provided, but hopefully also reducing the incidence of post PCI hospital readmission.

## Chapter Three

### Conceptual and Operational Definitions

1. Percutaneous Coronary Intervention (PCI): Any procedure performed in a Capital Health Region Cardiac Catheterization Lab via needle-puncture of the skin as a means to relieve coronary artery narrowing as recorded on the APPROACH registry database from January 2002 to December 2004.
2. Hospital Readmission: Admission to any hospital in the Capital Health Region after being formally discharged from the same or different facility as reported by the Capital Health Region Administrative Database ICD-10 coding up to and including six months after PCI.

### Methods

*Research Design*

This study was conducted using a retrospective descriptive design. The desired outcome of descriptive designs is a description of the data in words, pictures, charts or tables, as a means to answer the question [43]. A descriptive design was deemed most appropriate for this project because there is limited knowledge about the frequency of hospital readmissions post PCI as well as the causes of these readmissions.

*Setting*

The settings for this research study were the two Cardiac Catheterization Laboratories within the Capital Health Region of Alberta, Canada.

*Sample*

The target populations of this study included patients undergoing PCI in the Capital Health Region. A non-probability convenience sample was obtained through the Alberta Provincial Project for Outcome Assessment in Coronary Heart Disease (APPROACH) registry. The APPROACH registry is an ongoing prospective data

collection initiative that began in January 1995[43]. The registry captures data on the cohort of patients undergoing cardiac catheterization in the province of Alberta, Canada. More recently, partnerships have been developed with British Colombia, Saskatchewan, Manitoba and Nova Scotia. These provinces will be implementing APPROACH and contributing to the knowledge and information in the database. APPROACH provides a means to study and assess the processes and outcomes of care for patients with CAD. Individuals in APPROACH consent to be followed longitudinally after cardiac catheterization allowing for assessment of subsequent procedures as well as outcomes of procedures including mortality and quality of life. Detailed baseline clinical information is obtained, along with subsequent short and long-term outcomes on all patients undergoing cardiac catheterization. Personal identifiers are removed from analytical versions of the database to maintain patient confidentiality[43].

*Inclusion and Exclusion Criteria*

Eligible subjects included patients over the age of 18 years who underwent PCI at a Cardiac Catheterization Laboratory in the Capital Health Region within the time periods of January 2002 – December 2004, who were residents in the Capital Health Region and who consented to be enrolled in the APPROACH cohort. Subjects were limited to Capital Health Region residents to best capture readmission frequency post PCI. Postal codes were used to determine the patient's place of residence and then were stripped from the analytical version of the data. Patients requiring emergency PCI were excluded from the study.

*Consent*

Before being enrolled in the APPROACH database, patients were approached for consent at the time of their cardiac catheterization. A Registered Nurse who was not directly involved in the APPROACH project explained the

APPROACH database to the patient and provided them with an information form to read. Once consent was obtained, the form was signed and a copy of the consent form was given to the patient for future reference [43].

*Attrition*

Attrition in this study was not a threat as the design was retrospective. All data required for this study had already been obtained prior to its commencement and existed in previously developed databases.

*Data Collection*

Sociodemographics, clinical and co-morbid conditions as well as coronary anatomy were collected through the APPROACH database. Data collection forms were completed at the time of cardiac catheterization by the referring cardiologist and were entered into the on-site computers by cardiac catheterization laboratory staff. The computers are linked to a server located at the University of Alberta. Data collected at the time of cardiac catheterization included;

1. Sociodemographic Data (sex, age, address and postal code),
2. Presence or Absence of Co-morbidities (renal insufficiency, hypertension, hyperlipidemia, diabetes mellitus, peripheral vascular disease, cerebrovascular disease, smoking status, pulmonary disease, liver/gastrointestinal disease, malignancy),
3. Disease Specific Variables (congestive heart failure, prior myocardial infarction, prior thrombolytic therapy, Canadian Cardiovascular Society Angina Class, results of non-invasive tests), and
4. Coronary Angiography Results (coronary anatomy, extent of coronary stenosis, left ventricular ejection fraction).

Results of interventional procedures (i.e. PCI) were also recorded. Subsequent interventions and cardiac catheterizations were also captured by the APPROACH

database. Priority of the cardiac catheterization (urgent, emergent or outpatient) was recorded, along with any procedural complications that may have occurred[43].

Patients who had a PCI during cardiac catheterization between the time periods of January 2002 to December 2004 were identified by the APPROACH database. Patient data was then examined for a period of six months following the initial PCI. Incidences of hospital readmission or emergency room visits were determined using the Capital Health Region Administrative database. The International Classification of Disease, 10th version (ICD-10) code assigned to each admission was used to determine reasons for readmission as well as reasons for emergency room visits. The ICD-10 code is assigned by trained medical coders who read through the patient's medical chart to determine the diagnoses and co-morbidities that best describe a patient's hospitalization[44]. Every discharge record contains a unique identification number for each admission, a patient chart number, up to 16 diagnoses, up to 10 procedures, and an indicator flagging the occurrence of death during hospitalization[44].

Determining the appropriate time interval that will accurately indicate an unplanned hospital admission is challenging and very debatable [45]. Observation time has been shown to affect the calculation of readmissions and a longer time interval has been shown to create a greater number of "false positives" or unrelated admissions [45]. Epithelialization of drug eluting stents may take up to six months[4], therefore in order to capture all PCI related hospital readmissions, six months was chosen as the most appropriate period of time to observe for readmission. Reasons for admission were also documented to eliminate the possibility of including admissions unrelated to PCI complications in the study.

*Data Analysis*

Data Analysis was completed in three phases: (a) descriptive summaries, (b) Chi Square test of association and (c) Logistic Regression Analysis.

The first phase involved the creation of descriptive summaries of the data collected using the SPSS program. Frequency tables were used and measures of central tendency including means, medians and modes were determined. Tables were used to display the data.

The second phase included the creation of cross tabulations and Chi-square tests. The data collected was categorical, thus Chi-square was deemed appropriate. The assumptions associated with Chi-square: frequency data, adequate sample size, measures independent of each other and theoretical basis for the categorization of the variables, were met[46]. Chi-square tests of association were performed on the independent variables obtained to determine what associations existed between the variables and hospital readmission. Continuous data was analyzed using t-tests. Significance was set at $p \leq 0.05$.

The final phase included a logistic regression analysis to determine the percent of variance in the dependent variable explained by the independents [47]. Crude odds ratios were determined for each variable and those variables with a significance of $p \leq 0.20$ were then included into the logistic regression model. An enter method was performed to determine the probability of having a repeat hospital visit of any kind post PCI.

The latest version of the SPSS software was used to aid analysis.

## Reliability and Validity

The data collected through the APPROACH registry is entered into the database by cardiac catheterization lab personnel, allowing for ongoing collection of data, 24 hours per day, seven days per week [43]. Data entry is aided and guaranteed

as the computer program created for entering data into the APPROACH database is used by cardiac catheterization laboratory staff to create patient reports, facilitate other staff functions and streamline patient flow[43]. The variables collected by APPROACH conform to the published data and is considered the most necessary information needed to assess the relationship between processes of care and outcomes of care. Variables are reviewed on an ongoing basis and changes to the information collected in the database are made as new literature findings deem it necessary. APPROACH captures only the patient's current clinical information at the time of cardiac catheterization and future clinical diagnoses made may not be reflected in the database. In an attempt to deal with this issue the APPROACH data undergoes a yearly data enhancement procedure in which it is merged with administrative data obtained from the hospitals and assessed for the presence or absence of patient variables. The APPROACH database is also merged biannually with mortality data from the Vital Statistics Registry. The APPROACH database has captured data from more than 99% of all cardiac catheterizations in Alberta since 1995 and has been used to monitor the impact of health policies and to explore various other cardiac related research questions[43].

The International Classification of Diseases is a system that was developed collaboratively between the World Health Organization (WHO) and ten international centers. The purpose of the system is to support international comparability in the collection, classification, processing, and presentation of health statistics. Trained medical coders read through the patient's medical charts to assign ICD-10 diagnosis and procedure codes that appropriately describe a patient's hospitalization [44]. The accuracy of ICD-9 coding system was recently studied and it was found that although not all co-morbidities were captured, the ICD-9 coding system appeared to be accurate in describing the primary diagnosis [44].

## Ethical Considerations

The research proposal was submitted to the Health Research Ethics Board at the University of Alberta for review and approved. All participants in the APPROACH database are informed of the database prior to their cardiac catheterization and consent to all future studies involving their data at that time. Individuals who have consented to the APPROACH database also consent to be followed longitudinally after cardiac catheterization. Personal identifiers (i.e. personal health care numbers and patient names) were stripped from the analytical versions of the database before being exported into statistical software packages to protect patient confidentiality. A copy of the APPROACH consent form (See Appendix A) is given to participants and they are encouraged to contact the Project Manager at any time if they have any questions or concerns or if they wish to be removed from the APPROACH database.

The Health Research Ethics Board has reviewed the protocol involved in the APPROACH project and has deemed it acceptable (See Appendix B). As well, the APPROACH investigators agreed to provide the researcher with access to the data collected in the APPROACH registry (See Appendix C). In turn, the researcher agreed to maintain confidentiality of the data provided by the APPROACH database (See Appendix D).

A secondary dataset was used for this study and therefore no direct contact was made to any participant. Files in the analytical version of the database did not contain names and were without any identifying features. Although postal codes were used to confirm the patient's place of residence, they were stripped from the analytical version of the data.

## Chapter Four

### Presentation of Findings

The purpose of this study was to determine the frequency of and reasons for readmission to hospital post PCI among patients who had undergone PCI between January 2002 and December 2004 in the Capital Health Region. The APPROACH database was used to identify study subjects that fit the inclusion criteria. ICD-10 coding was used to determine if and when patients were readmitted to hospital, as well as the most responsible diagnosis. Descriptive statistics for patient characteristics are reported. Frequencies of variables are described. Chi-square analysis was used to analyze the relationship between the categorical variables and repeat hospitalization and *t*- tests were used to analyze the relationship between continuous variables and repeat hospitalization. Logistic regression was done to determine the probability of having a repeat hospital visit of any kind post PCI. Statistical significance was set at $p \leq 0.05$.

### Description of Subjects

Between January 2002 and December 2004, a total of 2641 subjects met the inclusion criteria for the study. The sample consisted of 684 females (25.9%) and 1957 males (74.1%), ranging in age from 27.9-93.6 years (median 63.0, mean 63.0, SD 11.9) (Figure 1). The mean age of the males was 61.4 and the mean age of the females was 67.7 ($p \leq 0.001$). The mean BMI for the sample group was 27.2.

Table 1 shows the baseline characteristics of the patients. Comorbidities were common, with hyperlipidemia noted in 78.3%, hypertension in 58.1%, NIDDM in 20.7%, and those who had experienced a previous MI accounted for 16.8% of the sample.

**Figure 1. Age of Subjects**

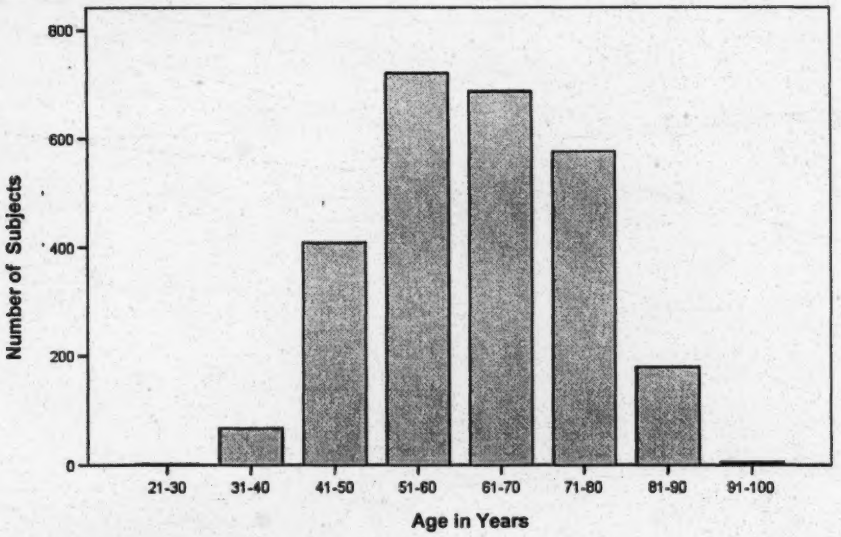



**Table 1. Baseline Characteristics**

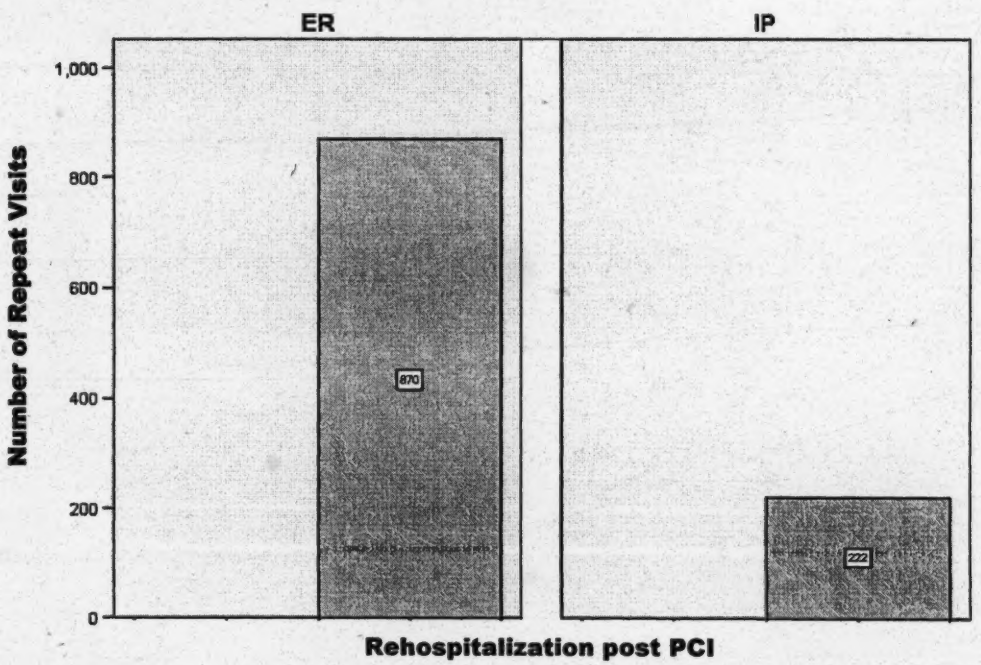
| Variable | N | % |
|---|---|---|
| Males | 1957 | 74.1 |
| Hypertension | 1531 | 58 |
| Hyperlipidemia | 2068 | 78.3 |
| IDDM | 37 | 1.4 |
| NIDDM | 546 | 20.7 |
| Priority of PCI | | |
| Urgent In-hospital | 1840 | 69.7 |
| Urgent Out-of hospital | 53 | 2 |
| Planned | 511 | 9 |
| Smoking Status | | |
| Current | 747 | 29.9 |
| Previous | 967 | 38.7 |
| Never | 610 | 24.4 |
| Unknown | 176 | 7.0 |
| Previous MI | 444 | 16.8 |
| Prior PCI | 94 | 3.6 |
| Prior CABG | 200 | 7.6 |
| Heart Failure | 140 | 5.3 |
| Peripheral Vascular Disease | 134 | 5.1 |
| Cerebrovascular Disease | 117 | 4.4 |
| Renal Failure Requiring Dialysis | 38 | 1.4 |
| Pulmonary Disease | 214 | 8.1 |
| Malignancy | 74 | 2.8 |
| Liver Disease | 15 | 0.6 |
| GI Disease | 147 | 5.6 |

In total, 1840 (69.7%) PCIs were done on an urgent in-hospital basis, 511 (19.3%) were planned, 237 (9%) PCIs were done on an urgent out of hospital basis, and 53 (2%) were unknown. In-hospital mortality for patients was 4.7% (n=125).

## Hospital Readmissions

Of the 2641 subjects included in the study, 870 (32.9%) visited the Emergency Room (ER) and 222 (8.4%) were readmitted to hospital within 6 months of the index PCI (Figure 2). The mean time to repeat visit was 1.9 months (median 1.3 months) (Figure 3). The mean number of visits was 2.5 (median 2.0) with 19% having 1 visit and 23% having greater than 1 visit. Unfortunately, the data did not differentiate between those visits that were planned and unplanned; however it can be assumed that the ER visits were not planned visits to the hospital.

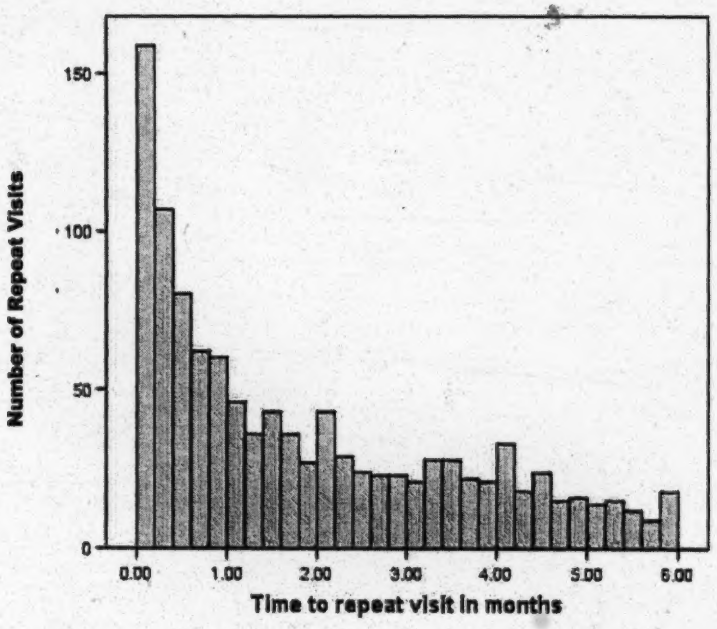
**Figure 2. Type of Repeat Visit to Hospital Post PCI**




Legend

ER= Emergency Room Visit
IP= In-Patient Hospital Admissions

**Figure 3. Time to Rehospitalization post PCI**




Male patients (p=0.002), those having PCI done on an urgent out-patient basis (p≤ 0.001) as well as those having PCI done on a planned basis (p≤ 0.001) were significantly more likely to have an in-patient hospital readmission (Table 2). Additionally, patients with NIDDM (p=0.002), peripheral vascular disease (p=0.009), pulmonary disease (p=0.001), liver disease (p=0.008) and those having had previous MIs (p=0.022) were significantly more likely to be readmitted to hospital (Table 2). Finally, the age groups of 61-70 (p=0.014) and 71-80 (p=0.014) were significantly more likely to be readmitted as in-patients.

Female patients (p=0.002), those having PCI on an urgent in-hospital basis (p≤ 0.001) as well as those with heart failure (p≤ 0.001) were significantly more likely to seek medical care in the ER and then be discharged home (Table 2). In addition,

the age groups of 31-40 (p=0.014) and 81-90 (p=0.014) were significantly more likely to seek medical care in the ER and then be discharged home.

**Table 2. Type of hospital visit post PCI**

| Independent Variable | In-patient Admission % | ER Visit % | p-value |
|---|---|---|---|
| Female | 23.4 | 30.2 | 0.002 |
| Male | 76.6 | 69.8 | 0.002 |
| Priority | | | |
| Urgent In-Hospital | 64.4 | 77.0 | ≤0.001 |
| Urgent Out-Hospital | 12.2 | 7.1 | ≤0.001 |
| Planned | 23.0 | 13.6 | ≤0.001 |
| Hypertension | 59.0 | 60.1 | 0.234 |
| Hyperlipidemia | 79.3 | 76.6 | 0.309 |
| IDDM | 0.9 | 1.7 | 0.550 |
| NIDDM | 28.4 | 22.1 | 0.002 |
| Smoking Status | | | |
| Current | 25.5 | 28.4 | 0.370 |
| Previous | 44.0 | 39.4 | 0.370 |
| Never | 25.5 | 24.7 | 0.370 |
| Previous MI | 23.4 | 16.3 | 0.022 |
| Prior CABG | 9.5 | 7.1 | 0.502 |
| Prior PCI | 1.8 | 3.6 | 0.320 |
| Heart Failure | 7.2 | 7.4 | ≤0.001 |
| Peripheral Vascular Disease | 8.1 | 6.1 | 0.009 |
| Cerebrovascular Disease | 5.0 | 5.3 | 0.248 |
| Renal Failure Requiring Dialysis | 2.3 | 2.0 | 0.107 |
| Pulmonary Disease | 11.7 | 10.1 | 0.001 |
| Malignancy | 4.1 | 4.1 | 0.003 |
| Liver Disease | 1.4 | 1.0 | 0.008 |
| GI Disease | 6.3 | 6.6 | 0.210 |

Age was also noted to be significantly related to the number of times a patient sought medical attention at a hospital (p=0.012). As the patient's age increased, they had more hospital visits (ER visits and in-patient hospitalizations included). The 21-30 age group had a mean of 2.0 visits, the 31-40 age group had a mean of 1.9 visits,

the 41-50 age group had a mean of 2.1 visits, the 51-60 age group had a mean of 2.2 visits, the 61-70 age group had a mean of 2.4 visits, the 71-80 age group had a meant of 2.8 visits, the 81-90 age group had a mean of 2.9 visits and there was a mean of 4.5 visits in the 91-100 age group. Age was not noted to be significantly related to the time to repeat hospitalization (p=0.459). Additionally, the number of visits were not noted to be statistically related to the whether the patient visited the ER or was admitted as an in-patient (p=0.842).

## Reasons for Readmission

Numerous reasons for readmission to hospital were apparent when reviewing the ICD-10 data. The diagnosis descriptions were independently reviewed by an expert in the Interventional Cardiology field (M.G.) and the ICD-10 diagnoses that were deemed to be related to PCI were categorized into 21 separate categories (Table 3).

Of the 1092 subjects that had a repeat hospital visit following their PCI, 610 (56%) visited the hospital for reasons that were related to PCI. Of these 610 patients, 491 (80%) visited the ER and then were discharged home and 119 (20%) were subsequently admitted as in-patients. The most common reason for the ER visit was chest pain (32%), followed by atherosclerotic heart disease (13.3%), MI (5.9%), congestive heart failure (3.7%) and bleeding complications (3.6%) (Table 4).

The most common reasons for being admitted as an in-patient were chest pain (17.1%), atherosclerotic heart disease (13.1%), bleeding (5.9%), MI (4.1%), procedural complications (3.6%), congestive heart failure (2.3%) and phlebitis (1.4%) (Table 4).

Time to readmission was noted to be significantly related to the type of readmission to hospital ($p \leq 0.001$). Patients who were admitted as in-patients took longer to return to hospital with a mean readmit time of 2.3 months (70.1 days).

Patients who visited the ER returned to hospital earlier with a mean readmit time of 1.8 months (54.6 days). No statistically significant difference was noted between the top five reasons for readmission and time to readmission (chest pain p=0.321, atherosclerotic heart disease p=0.668, MI p=0.664, bleeding p=0.950, procedural complications p=0.609).

**Table 3. ICD-10 Codes used to identify Reasons for Readmission**

| Reasons for Readmission | ICD-10 Code |
|---|---|
| Bleeding/Complications with Anticoagulation | 2859, 79092, D649, D683, I620, K290, K625, K920, K921, K922, R040, R310, R318, R58, T810, Y442 |
| MI | 41011, 41091, 4111, I210, I211, I213, I2141, I2149, I219, I221, I249 |
| Renal Failure | N179, N19, N990 |
| Cerebrovascular Disease/Complications | 4359, 436, G459, I64 |
| Procedural Complications | I978, M7983, M7986, R098, T812, T8188, T828, T888, Y840, Z480 |
| Chest Pain | 4139, 78650, 78659, I200, I2088, I209, I2382, R073, R074 |
| Atherosclerotic Heart Disease | 4149, I251, I2510, I2511, I2519, I259, I702 |
| Arterial Aneurysm | I724 |
| Cardiac Arrest | I460, I469 |
| CHF | 4280, I500 |
| Dehydration | E860 |
| Pericardial Disease | I319 |
| Ventricular Tachycardia | I472 |
| Shortness of Breath | R060 |
| Infection | A419, T814 |
| Orthostatic Hypotension | I951 |
| Pulmonary Embolism | I269 |
| Embolism and Thrombosis of Arteries of Lower Extremities | I743 |
| Pain | M545, M7960, M7961 |
| Phlebitis | I802 |
| Syncope | R55 |

**Table 4. Reasons for Hospital Visit post PCI**

| Reason for Hospital Visit | ER Visits n | ER Visits % | In-Patient Admissions n | In-Patient Admissions % |
|---|---|---|---|---|
| Chest Pain | 159 | 32.4 | 38 | 31.2 |
| Atherosclerotic Heart Disease | 116 | 23.6 | 29 | 24.3 |
| Myocardial Infarction | 51 | 10.4 | 9 | 7.5 |
| Bleeding/ Complications with Anticoagulation | 31 | 6.3 | 13 | 10.9 |
| Procedural Complications | 34 | 6.9 | 8 | 6.7 |
| Congestive Heart Failure | 32 | 6.5 | 5 | 4.2 |
| Dehydration | 13 | 3.3 | 1 | 0.8 |
| Syncope | 11 | 2.2 | 2 | 1.6 |
| Shortness of Breath | 8 | 1.6 | 1 | 0.8 |
| Renal Failure | 6 | 1.2 | 2 | 1.6 |
| Cerebrovascular Disease/ Cerebrovascular Complications | 6 | 1.2 | 2 | 1.6 |
| Phlebitis | 2 | 0.4 | 3 | 2.5 |
| Pain | 4 | 0.8 | 2 | 1.6 |
| Pulmonary Embolism | 4 | 0.8 | 1 | 0.8 |
| Cardiac Arrest | 4 | 0.8 | 0 | 0 |
| Orthostatic Hypotension | 4 | 0.8 | 0 | 0 |
| Infection | 2 | 0.4 | 1 | 0.8 |
| Ventricular Tachycardia | 3 | 0.6 | 0 | 0 |
| Arterial Aneurysm | 0 | 0 | 2 | 1.6 |
| Pericardial Disease | 1 | 0.2 | 0 | 0 |
| | 491 | | 119 | |

## Predicting Hospital Readmission

Logistic regression can be used to predict a dependent variable on the basis of continuous and/or categorical independents and to determine the percent of variance in the dependent variable explained by the independents [47]. For this study, crude odds ratios were determined for each variable on its own. Those variables with

a significance of p≤ 0.20 were then included into an adjusted logistic regression model. An enter method was performed to determine the probability of having a repeat hospital visit of any kind post PCI (Table 5).

When the seven significant variables were entered into the logistic regression model, female gender, congestive heart failure, pulmonary disease, malignancy and liver disease continued to be independently predictive of repeat hospital visits. Patients with liver disease are 5.1 times more likely to either visit the ER or be readmitted to hospital and patients with malignancies are 2.2 times more likely to have a repeat visit to hospital. Additionally, patients with congestive heart failure are 1.6 times more likely to have a repeat hospital visit, patients with pulmonary disease are 1.5 times more likely to have a repeat hospital visit and female patients are 1.2 times more likely to have a repeat visit to hospital post PCI (Table 5).

**Table 5. Predictors of Readmission to Hospital post PCI**

| Variable | Crude Odds Ratio (95% Confidence Interval) | p | Adjusted Odds Ratio (95% Confidence Interval) | p |
|---|---|---|---|---|
| Age | 1.005 (0.997-1.012) | 0.207 | | |
| Female | 1.194 (0.992-1.436) | 0.061 | 1.247(1.044-1.490) | 0.015 |
| Hypertension | 1.041 (0.881-1.229) | 0.638 | | |
| Hyperlipidemia | 0.915 (0.755-1.108) | 0.362 | | |
| IDDM | 1.110 (0.565-2.178) | 0.763 | | |
| NIDDM | 1.188 (0.974-1.450) | 0.090 | 1.204 (0.991-1.462) | 0.062 |
| Prior MI | 1.022 (0.819-1.277) | 0.845 | | |
| Prior CABG | 0.916 (0.673-1.247) | 0.576 | | |
| Congestive Heart Failure | 1.534 (1.067-2.205) | 0.021 | 1.616 (1.130-2.311) | 0.009 |
| Prior PCI | 0.780 (0.500-1.216) | 0.273 | | |
| Peripheral Vascular Disease | 1.295 (0.897-1.868) | 0.167 | 1.335 (0.930-1.917) | 0.117 |
| Cerebrovascular Disease | 1.097 (0.747-1.612) | 0.637 | | |
| Renal Failure requiring Dialysis | 1.509 (0.764-2.981) | 0.236 | | |
| Pulmonary Disease | 1.420 (1.060-1.902) | 0.019 | 1.474 (1.105-1.967) | 0.008 |
| Malignancy | 2.057 (1.269-3.335) | 0.003 | 2.153 (1.335-3.471) | 0.002 |
| Liver Disease | 4.832 (1.334-17.499) | 0.016 | 5.097 (1.420-18.294) | 0.012 |
| GI Disease | 1.172 (0.830-1.655) | 0.368 | | |

## Chapter Five

### Discussion of Findings

A retrospective descriptive design was conducted to identify the frequency of and reasons for readmission to hospital post PCI in the Capital Health Region. Using the Alberta Provincial Project for Outcome Assessment in Coronary Heart Disease (APPROACH) registry database, patients who had undergone PCI from January 2002 - December 2004 were identified. The frequency of hospital visits as well as hospital readmissions were tracked for six months following PCI. The incidence of and reasons for hospital readmission were determined using the Capital Health Region Administrative Database and the ICD-10 coding for hospital readmission. Data analysis included descriptive statistics to describe subject demographics as well as all study variables. Analysis of relationships between study variables and repeat hospitalization was conducted using Chi-square analysis and *t*- test was used for analysis of relationships between continuous variables and repeat hospitalization. Logistic regression was used to help predict the probability of patients being readmitted to hospital post PCI.

### Frequency of Hospital Readmission

The demographic characteristics for this study were those typically found in patients with coronary artery disease (CAD). Patients who are older and are of the male gender have been shown to be at increased risk of developing CAD [48]. In this study, 74% of subjects were male and 26% were female with the mean age being 68 years.

Previous studies have reported a repeat hospitalization rate post PCI of 15-50% [13, 41, 42] which is similar to the findings of this study where 41% of patients returned to hospital (either having an ER visit, or an in-patient admission) within 6 months of the index PCI. However, this study showed that only 4.5% of patients had

in-patient readmissions that were directly related to PCI, significantly less than reported by Lubitz, et al. who suggested that 34.6% of hospital readmissions within one year were directly related to PCI [42]. This drop in readmissions may be attributed to the improved techniques in performing angioplasty since 1993 when Lubitz et al. completed their study. The difference may also be due to the differing time periods that hospital readmissions were observed for (6 months versus 1 year), keeping in mind that a greater time following patients may lead to a greater number of "false positives" or unrelated admissions [45]. Additionally, different criteria may have been used to determine whether an admission was or was not related to the index PCI.

Although no previous study differentiated between ER visits and in-patient admissions, it is interesting to note that the majority of repeat hospital visits were ER visits (80%) while only 20% of repeat hospital visits were actually in-patient admissions. It is unknown if previous studies that examined hospital readmission looked only at in-patient visits or if they looked at ER visits as well. If only in-patient visits were looked at, the readmissions observed in this study were significantly lower than that of previous studies accounting for 4.5%, while ER visits accounted for 18.6%. This difference in in-patient admissions, if real, could be explained by differing techniques, improved technologies and/or the type of patient teaching provided by the health care professionals at the time of PCI. Additionally, as stated previously, different criteria may have been used to determine if a hospital readmission was actually related to PCI.

Another interesting finding of this study was that patients who had ER visits returned to hospital in a mean time of 1.8 months, whereas patients who were readmitted as in-patients returned to hospital in a mean time of 2.3 months, a statistically significant difference. This could be explained by an elevated anxiety level among recent PCI patients, causing them to visit the ER sooner. It is also

possible that the reason for this difference is that those patients requiring admission to hospital may have been experiencing symptoms for a longer period of time prior to seeking medical attention than those who visited the ER. This increase in time may have made their complication more severe, thus requiring closer medical attention. The reasons for returning to hospital were distributed in a similar manner for both ER visits and in-patient admission with the top 2 reasons for readmission both being chest pain (32% and 31% respectively) and atherosclerotic heart disease (24% of patients in each category).

It is important for health care professionals to realize that the impact of hospital readmission may be very much underestimated as it appears the majority of patients are not actually admitted as in-patients, but are seeking medical care in emergency rooms. The reasons for these visits may be due to actual complications post PCI, or may be prompted by patients who are anxious and have questions or concerns after PCI. It is also unknown how many of these patients visited their family physicians or cardiologists with questions and concerns post PCI and how many complications were managed by these physicians, without the patient ever visiting a hospital, creating a further underestimation of post PCI complications.

Post PCI follow up clinics have been shown to be successful in reducing the incidence of post procedural complications as well as encouraging patients to engage in more lifestyle changes and risk factor modification [8, 10]. Additionally, hospital based follow up clinics have been observed to decrease the number rehospitalizations, compared to the standard follow up by community physicians [40].

A telephone "hotline" provided to patients after PCI where a health professional could be reached who is knowledgeable about PCI and the potential ensuing complications could possibly reduce ER visits, outpatient clinic visits and in-patient admissions substantially. Additionally, patients following up in a post PCI

follow-up clinic could potentially have complications detected sooner, thus reducing further hospital visits. These follow-up clinics could also provide further teaching on coronary artery disease and risk factor reduction, possibly helping to lower the incidence of further disease progression.

Age was noted to be related to the number of repeat hospitalizations with an increasing age resulting in an increased number of hospitalizations. The mean number of repeat visits increased from 2.0 visits in the 21-30 age group to 4.5 visits in the 91-100 age group. Elderly patients may be more likely to have a hospital visit due to an increase in anxiety or a decreased ability to retain health teaching while at the hospital. Another factor contributing to older patients having more hospitalizations may be that older patients are more likely to have co-morbidities that may put them at higher risk of developing complications post PCI. For example, patients in the 61-70 year old age group were more likely to have had prior PCI and CABG, congestive heart failure, peripheral vascular disease, cerebrovascular disease, renal failure requiring dialysis, pulmonary disease and malignancies.

Male patients, those having PCI done on an urgent out-patient basis as well as those having PCI done on a planned basis were significantly more likely to have an in-patient hospital readmission. Additionally, patients with NIDDM, PVD, pulmonary disease, liver disease, those having had previous MIs and those aged 61-70 and 71-80 were significantly more likely to be readmitted as in-patients. ER visits were more common in females, patients with heart failure and those having urgent in-hospital visits.

The difference in the type of male versus female visits to hospital may be due to the difference in medical seeking behavior between men and women. Women traditionally seek medical attention more frequently and sooner than men, [49] thus when medical attention was sought by women in the ER, a hospital admission may

not have been deemed necessary. Whereas men traditionally seek medical attention infrequently and much longer after the onset of symptoms, [49] thus when men sought medical attention, a hospital admission may have been necessary to best deal with the issue. These differences may support the need for earlier intervention in patients post PCI as many patients access the medical system in different ways and at different times. If patients are routinely followed up in the early post PCI period, access to health care may be improved, allowing complications to be observed sooner and care to be given quicker. This improved access to health care may decrease the need for costly in-patient readmissions and decrease ER waiting times.

## Reasons for Readmission

Unfortunately, other studies that have examined repeat hospitalization post PCI have not reported the reasons for readmission. In this study, the top 5 reasons for in-patient readmission to hospital were noted to be chest pain (31.2%), atherosclerotic heart disease (24.3%), bleeding/complications with anticoagulation (10.9%), MI (7.5%) and procedural complications (3.7%). However, as chest pain has been reported to occur in patients as frequently as 23-30% of the time post PCI [27-29], it is not surprising that chest pain is the number one reason for repeat visits to hospital. Additionally, as chest pain continues to be the hallmark symptom of MI, it seems likely that patients would return to hospital when experiencing this symptom in fear of an infarction. It is also interesting to note that chest pain continued to be the number one reason when patients sought medical attention in the ER. Unfortunately, it could not be ascertained whether the severity of chest pain, or ST segment changes differed between the two groups justifying those who were admitted as in-patients and those who were discharged home from the ER.

Previous studies examining vascular complications reported a complication rate of 0.77%-10.3% [21, 22, 25, 26]. This study found similar results with 0.2% of patients

experiencing arterial aneurysm and 0.5% of patients experiencing phlebitis. Those patients that experienced post PCI bleeding accounted for 4% of the sample, however this variable accounted for all bleeding complications, not just bleeding at the insertion site.

## Predicting Readmission to Hospital post PCI

After creating a logistic regression model, five variables were noted to independently predict a repeat hospital visit post PCI (either ER visit or in-patient admission). Patients with liver disease were noted to be 5.1 times more likely to have a repeat visit, and patients with malignancies were 2.2 times more likely to have a repeat visit. Additionally, patients with congestive heart failure were noted to be 1.6 times more likely to have a repeat hospital visit, those with pulmonary disease were 1.5 times more likely to have a repeat visit and female patients were 1.2 times more likely to either have an ER visit or be readmitted to hospital as an in-patient. These predictors have only one similarity to those reported by Halon, et al. whose model identified hypertension, incomplete revascularization and female gender as predictors of readmission [41]. This study did not examine the completeness of revascularization, however hypertension was not found to be predictive of hospital readmission. On the contrary, female patients were found to be 1.2 times more likely to either have an ER visit or be readmitted to the hospital as an in-patient, similar to the study done by Halon, et al. where it was found that female patients were 2.2 times more likely to be readmitted to hospital post PCI [41].

Knowledge of the predictors of rehospitalization post PCI may make it possible to allow more time and attention to be given to teach and support these patients in order to reduce the occurrence of future readmissions post PCI.

## Limitations of the Study

This study may not capture all patients readmitted to hospitals. Patients who were readmitted to a hospital outside of the Capital Health Region were not included in the study in order to capture all hospital readmissions. Patients living in other health regions could be readmitted to a multitude of other institutions, rendering the tracking of readmissions nearly impossible. However, it is felt that by creating this limitation, the majority of hospital readmissions among the study subjects were captured.

Another limitation of this study is that the ICD-10 coding may not have accurately captured the reasons for readmission with all patients. A study done on the accuracy of the ICD-9 coding system found that although not all co-morbidities were captured, the ICD-9 coding system appeared to be accurate in describing the primary diagnosis [44]. It is therefore likely that the primary reason for hospital readmission was be captured by the ICD-10 code.

One more limitation is that the ICD-10 reason for admission of "atherosclerotic heart disease" is vague and it was unclear exactly what this diagnosis encompassed. Although it was viewed that this diagnosis was related to the PCI, the vagueness of the term may have contributed to a higher estimation.

A forth limitation is that it is unknown how many patients visited their family physician post PCI for problems and concerns related to the PCI, potentially underestimating the number of patients who had problems post PCI.

One final limitation is that it is uncertain how many in-patient admissions were planned. Unfortunately the data collected did not differentiate between planned and unplanned admissions, therefore the number of in-patient readmissions reported may be slightly elevated.

## Conclusions

Rehospitalization post PCI can have an enormous impact on both the health care system as well as patients' lives. Previously, this issue had not been thoroughly examined, although it was thought that the incidence of readmission post PCI may be significantly underestimated [13].

This study has revealed that nearly half of all PCI patients are either admitted to hospital or visit the ER within six months of PCI, and one quarter of patients visit the hospital for reasons that are directly related to the PCI. Although actual in-patient hospital admission was relatively low at 4.5%, ER visits were substantial with 18.5% of the study sample visiting the ER for a PCI related complaint. The comorbidities of congestive heart failure, pulmonary disease, cancer and liver disease were found to be predictive of readmission to hospital.

The information from this study can be used to help focus post PCI teaching to those patients that may have a higher incidence of readmission post PCI, potentially reducing their need for readmission. Moreover, it is possible that many of the hospital visits, specifically, the ER visits, were not necessary and may have been a result of patient anxiety and uncertainty. For these instances, the creation of a post PCI clinic and/or a post PCI hotline may prove to be useful in decreasing the number of hospital visits post PCI by giving patients a place to go for PCI follow-up as well as to call with any questions or concerns. If patients are routinely followed up in the early post PCI period, access to health care may be improved, allowing complications to be observed sooner and care to be given quicker. This improved access to health care may decrease the need for costly in-patient readmissions and decrease ER waiting times.

As it seems that returning to hospital post PCI is a relatively frequent occurrence, it is imperative that current procedures and practices be examined and

reevaluated in order to better assist patients post PCI. These actions my help to reduce the occurrence of hospital readmissions post PCI decreasing the effect it may have on the health care system as well as patient's lives.

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# Appendix A

Capital Health

**Consent Form II**
APPROACH

RESEARCH PROJECT: Alberta Provincial Program for Outcome Assessment in Coronary Heart Disease (APPROACH)

This consent form, a copy of which has been given to you, is only part of the process of informed consent. It should give you the basic idea of what the research project is about and what your participation will involve. If you would like more detail you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

We would like to follow all patients who undergo angiography in Alberta to determine long-term outcome and cost. This data will provide vital information on current and future resource needs and cost effectiveness of our treatment. This study involves **information gathering** only.

If you agree to participate you will be contacted by mail annually and asked to complete a simple questionnaire. For example, you will be asked to list your hospitalizations and costs of your medications in the last year and answer questions related to your chest pain. You may also be contacted by telephone. Your signature on this form gives Blue Cross permission to release your list of annual medication costs to the Data Collection and Analysis Group. The Minister of Alberta Health Care or her designate may furnish information pertaining to health services provided and the date and costs of these services. This information may only be furnished with your signature on this form.

There will be no costs to you by participating in this study. All of the information gathered will remain in strictest confidence and you will not be personally identified. This information will only be available to those investigators participating in the study for the purpose of analyzing the results.

Your signature on this form indicates that you have understood to your satisfaction the information regarding your participation in this project and agree to participate in this follow up. You are free to withdraw at any time. You should feel free to ask for clarification or new information throughout your participation. Your family physician and referring cardiologist have been notified of the APPROACH. If you have any further questions, please contact the Project Manager at 407-6828. If you have any questions concerning your rights as a possible participant in this research, please contact the Office of Medical Bioethics, Faculty of Medicine, The University of Alberta, at 492-6676.

We ask that if you relocate, you contact our Project Office at 407-6828 and leave a message so that we can keep your file current.

| NAME OF SUBJECT | NAME OF WITNESS | DATE |
|---|---|---|
| SIGNATURE OF SUBJECT | SIGNATURE OF WITNESS | |

Blue Cross coverage: ☐ Yes ☐ No TYPE: ☐ Group 66 ☐ Plastic Card ☐ Cardboard Card

Name and address of pharmacy _____

A copy of this consent form will be given to you. Please keep it for your records and future reference.

SP.8573 Apr 2002 White - APPROACH Canary - Patient

# Appendix B

Health Research Ethics Board

2J2.27 Walter Mackenzie Centre
University of Alberta, Edmonton, Alberta T6G 2R7
p.780.492.9724
p.780.492.0459
f.780.492.7303
ethics@med.ualberta.ca

**ETHICS APPROVAL FORM**

**Date:** November 2004

**Name(s) of Principal Investigator(s):** Dr. Michelle Graham

**Department:** Medicine

**Title:** Alberta Provincial Program For Outcome Assessment In Coronary Heart Disease

**Protocol#:**

The Health Research Ethics Board (Biomedical Panel) has reviewed the protocol involved in this project which has been found to be acceptable within the limitations of human experimentation. The REB has also reviewed and approved the patient information material and consent form.

**Specific Comments:**

D. W. Morrish, M.D.
Chairman, Health Research Ethics Board
Biomedical Panel

**This approval is valid for one year**

Issue: #1413

**Appendix C**

# APPROACH

## Alberta Provincial Project for Outcome Assessment in Coronary Heart Disease

April 6, 2005
To : Stephanie Wold MN Student
University of Alberta

This is to confirm that you will have access to data collected in the APPROACH registry. This data is restricted to patients catheterized at the Walter Mackenzie Health Sciences Centre who undergo a PCI. All of the information will remain in the strictest of confidences and no personal identification will be included in the data. The data will only be available to investigators participating in the study for the purposes of analyzing the results.

The signature on the attached confidentiality agreement indicates that you have understood to your satisfaction the information regarding the use of APPROACH data and agree to the conditions included in the letter.

We look forward to working with you.

Sincerely

Colleen Norris PhD
APPROACH Consultant - Epidemiology

# Appendix D

UNIVERSITY OF CALGARY

APPROACH
Alberta Provincial Project for Outcome Assessment in Coronary Heart Disease

UNIVERSITY OF ALBERTA

***Data Confidentiality Agreement***

I, the undersigned, agree to the following:

All data at the individual record level obtained or acquired through the APPROACH Database shall be treated as strictly confidential and shall not be disclosed or provided to any person who is not a research associate or employee of APPROACH or to any person who has not signed a Data Confidentiality Agreement. In addition:

1. No attempt shall be made to identify any individual contained in such records.
2. No aggregate data from such records shall be reported or published with a cell size less than six without written permission of the Clinical Steering Committee.
3. All data at the individual record level on computer tape, cartridge, disk, CD-ROM, other computerized storage media, or in hard copy shall be archived in a locked location.
4. All data at the individual record level on a computer hard drive shall be password protected.
5. Any breach or suspected breach of data confidentiality shall be reported immediately to the Clinical Steering Committee.

Any intentional violation of this agreement shall be the basis for dismissal for cause.

_____
(Signature)

April 6/05
Date

Stephanie Wald
(Print Name)

# Stephanie Lynn Wold RN, BScN, MN (c)

## EDUCATION

**Bachelor of Science in Nursing** (with Distinction)
University of Alberta – Edmonton, Alberta
April, 1999

**Masters in Nursing – Candidate**
University of Alberta – Edmonton, Alberta
Expected Graduation Date: Fall 2006
On the AARN Extended Practice Roster

## SUMMARY OF QUALIFICATIONS

- One year experience as a Nurse Practitioner Intern in Cardiovascular Surgery
- Six years experience as a RN in Cardiovascular surgery, five of these years in the Cardiovascular ICU
- Two years of experience in the Cardiac Catheterization Lab
- Highly skilled in systems assessment, critical care procedures, problem solving and patient care
- Knowledge of pharmaceutical agents and their use within the ICU
- Proficient in caring for critical post-op patients requiring sophisticated medical equipment such as IABP's and CRRT
- Strong verbal and written communication skills
- Strong interpersonal, analytical, organizational, problem solving and leadership skills
- Quick study with an ability to easily grasp, evaluate and implement new ideas, concepts and methodologies
- Advanced computing skills
- Committed to continuing education and promoting professional and personal growth in nursing
- Caring, empathetic healthcare professional

## PROFESSIONAL EXPERIENCE

**Nurse Practitioner Intern – CVICU, University of Alberta Hospital**
August 2005 - Present
**Registered Nurse – Cardiac Catheterization Lab, University of Alberta Hospital**
June 2003 – July 2005
**Registered Nurse – CVICU, University of Alberta Hospital**
September 2000 – July 2005
**Registered Nurse - CV Surgery, University of Alberta Hospital**
August 1999 – September 2000
**Registered Nurse – Neurosurgery, University of Alberta Hospital**
April 1999 – August 1999
**Registered Nurse – Oncology, Cross Cancer Institute**
April 1998 – August 1999

## PRESENTATIONS

*Are our Patients Extubated Early Post Cardiac Surgery?*
G. Urquhart, K. Scherr, C. Bulbuc, K. Coghlan, R. Fly, C. Hannem, C. Kozak, K. Lakhani, T. Meyer, A. Warrington, & **S. Wold.**
University of Alberta Hospital, Edmonton, AB, Canada
Presented at Canadian Cardiovascular Congress, Edmonton, AB, October 2002
And Dynamics of Critical Care Conference PEI, October 2003.

## PROFESSIONAL DEVELOPMENT

Current MN student at the University of Alberta
Executive Links Acute Coronary Syndrome Workshop (2004)
ACLS (2003)
Executive Links ECG Workshop, Edmonton, AB (2003)
CRRT in Critical Care, Edmonton, AB (2002)
Canadian Cardiovascular Congress, Edmonton, AB (2002)
Advanced Prisma Training Session, Edmonton, AB (2002)
International Heart & Lung Transplantation Conference, Vancouver, BC (2001)
Congestive Heart Failure Workshop, Edmonton, AB (2001)
CCEP Program UAH Hospital, Edmonton, AB (2000)

## RESEARCH

Master's Thesis – Completed Fall 2006
The Frequency of and Reasons for Hospital Readmission Post PCI
Supervisor – Dr Colleen Norris

## HONORS & AWARDS

UNA – Educational Funding – January, 2006
Ludmyla Zujewskyj Memorial Scholarship – November, 2005
AARN Educational Funding – October, 2004
Dean's List – University of Alberta - 1997-1999, 2005, 2006

## PROFESSIONAL MEMBERSHIPS

Alberta Association of Registered Nurses – Extended Practice Roster
Canadian Nurses Association
Canadian Council of Cardiovascular Nurses
Arizona State Board of Nursing